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Buffalo. In both places local researches in taxation and other economic subjects are also contemplated. The secretary of the Canton branch reports that Professor Ely's "Problems of To-Day" is being studied, and that "the members are enthusiastic."

The branches at Orange, N.J., and Washington, seem to have patterned largely after the Springfield plan.

These suggestions may furnish some help in the solution of the problem of how to extend the work and influence of the association, and form centres of economic study in many parts of our country.

THE WEATHER SERVICE.

THE popular dissatisfaction with the weather predictions as now furnished by the Signal Office has become so great, that a thorough discussion of what is best to be done to improve the service is certainly desirable. Such a discussion has been taking place in the columns of the *Boston Post*, and from that paper we here quote from a recent letter of Mr. H. H. Clayton of the Blue Hill Meteorological Observatory, Readville, Mass. In an editorial note the *Post* seems inclined to doubt the wisdom, if not the truth, of the sweeping assertion of the inefficiency of a large part of the Signal Corps made by Gen. Greely in his recent report to Congress, and it was this which called forth Mr. Clayton's letter in which he takes the following ground.

"Gen. Greely may possibly not be right in his specifications as to exactly what persons are inefficient, but any one who has studied the history of our weather service in comparison with that of foreign countries can scarcely doubt but there is great inefficiency somewhere in our service; and it seems right to allow Gen. Greely every assistance possible to improve the service, until there is proof that his efforts are in the wrong direction. The financial support and the facilities afforded our signal service are the best in the world, and it has been a continuous surprise to the writer that its efficiency has not been greater. The following figures show in round numbers the amount of money appropriated by various governments in Europe and America for the support of their weather services: United States, \$900,000; Great Britain, \$80,000; Germany, \$56,000; Russia, \$65,000; Austria, \$10,000; Switzerland, \$6,000; France, \$40,000. This estimate for France does not include the cost of observations made at a few astronomical observatories and mountain stations, which may perhaps increase the total amount expended by France to \$60,000. It is thus seen that the amount of money appropriated for its weather service by the United States is ten times greater than that of any country in the world, and is greater than the amount appropriated by all of the governments of Europe combined, including Italy and others not mentioned above.

"In Europe a large part of the observers are voluntary observers, or they are men who are engaged in other pursuits, and for a small compensation take meteorological observations, and telegraph them to the central stations. For this reason it has been necessary to adapt the observations somewhat to the convenience of the observers, and it has been impossible to obtain all over Europe a system of simultaneous observations such as are obtained in the United States. The principal set of observations in the different European countries is taken all the way from 7 A.M. to 9 A.M.; and on account of the difficulty of arranging codes, and transmitting telegrams from one country to another speaking different languages and having different interests, it is almost noon before the morning observations are in an available form in the different countries for use in making weather predictions, while in the United States it is but little more than an hour after the observations are taken before they are available for use at the central office. Again, owing to their small appropriations, none of the European countries have been able to obtain extensive reports more than once a day from surrounding countries, and thus form a set of relatively complete weather maps, such as was previously done three times a day in the United States, and is now done twice a day. The full weather map made by the European weather services is from the morning reports taken between 7 and 9 A.M., though most of the services make supplementary maps from less complete reports received in the afternoon and evening.

"So far, it is seen, then, that our weather service is better equipped, and with far better facilities for effective work, than any service in the world; but what are the results? In 1881 the per cent of verification of their weather predictions estimated by the French meteorological office was 82. Since then it has steadily risen, until, in 1888, a verification of 90 per cent was claimed. In the same manner the per cent of success estimated by the London office for Great Britain has risen from 78 per cent in 1882, to 83 per cent in 1887. In Germany the per cent has risen from about 80 per cent ten or twelve years ago, to 88 per cent in 1887. According to the official verifications of our signal service, the per cent of successful weather predictions rose from about 82 per cent in 1875, to 89 in 1883, and then decreased irregularly to 74 per cent in 1887, or 81 per cent when corrected for the greater interval covered by the predictions. These signal-service verifications for different years are not strictly comparable, because they were verified according to varying rules and with different degrees of care; but the signal service uses them so, and the figures at least agree with the general impression that there has been no increase in the accuracy of the signal-service predictions during the last fifteen years. Neither are the per cents of verification for one country comparable with another, since many of them were verified by different rules; but the results are comparable among themselves, and the steady increase of accuracy claimed for the European weather predictions is no doubt a fact. The able papers and investigations proceeding from the members of the European bureaus seem sufficient evidence that great thought is being given to the improvement of meteorology, and the advance of meteorological knowledge is undoubted.

"The great difficulty with our bureau seems to have been that Congress made it a military rather than a scientific organization. Several years ago a committee appointed to investigate the bureau recommended that it be transferred to a civilian organization, either gradually or suddenly. The National Academy of Science, when consulted on the subject, recommended the same thing; but for some reason unknown to the writer, Congress has neglected or refused to make such a transfer, and last year struck out a clause to that effect in the agricultural bill. There is scarcely any doubt, that, with some scientific investigation, certain of those storms might have been predicted which in recent years have struck our coast unheralded by the signal service, and left wreck and ruin behind,—notably the storm of Jan. 9, 1886, for which no signals were ordered, and in which it is estimated that about 125 vessels were wrecked on the New England coast. Were the weather service of our country in the hands of well-selected scientific men, it would undoubtedly become, as it ought to become with such splendid facilities as it now has, one of the finest meteorological bureaus in the world. If, however, this cannot be, it is hoped that every facility will be furnished Gen. Greely to make it an effective military organization. Gen. Greely's recent books and excellent 'Report of the Lady Franklin Bay Expedition to the Arctic Regions' indicate a deep interest in and a knowledge of the needs of meteorology, and he is no doubt sincere in his efforts to increase the efficiency of the Signal Corps.

"Besides the re-organization of the bureau, an immense advance might be made by organizing local predicting bureaus, where the predicting officers could make a closer study of the conditions surrounding them, and gain more time for prediction, instead of, as now, being compelled rapidly to make predictions for almost the entire length and breadth of our land, which is many times larger than any country of Europe, except Russia. The favor with which the Blue Hill predictions, as well as those of others in this and other parts of the United States, have been received, seems proof that local weather bureaus would be at once appreciated by the public."

MENTAL SCIENCE.

The Genesis of Error.¹

PROFESSOR S. EXNER of Vienna contributed to the Congress of German Naturalists and Physicians a very suggestive essay upon the principles underlying the origin of illusion in man and the ani-

¹ From the *Revue Scientifique*, Jan. 12, 1889.

mal world. The physicist, he observes, before deducing any result, takes into account the errors of his instruments. The scientist is always working with one certain instrument, the human mind. The errors of this ever-present factor in all work form a most important field of study.

In the study of instincts, such as those that direct birds in the building of their nests, insects in the formation of their communities, we often admire the wonderful resemblance of these complex acts to the results of reason. And yet we recognize an important distinction between them: their sphere is limited, their power of adaptation to new conditions is small. It is a remarkable mechanism, but has application to a limited number of movements. A bird shows remarkable skill in weaving the threads with which it builds its nest, fastening it to the limb of a tree, and adapting it to the shape of the twig. But tie the foot of a bird in a cage, and it cannot make use of its skill in weaving to untie the fastening, but struggles and flutters until it kills itself or is accidentally freed. Teleologically speaking, certain adjustments are ingrained in its nervous system; but these adjustments are special, not general. The more perfect the instinct, the more stable and invariable is it; the less rigidly the adjustments are ingrained, the more does the act resemble what we term "reason." Diversity and adaptability are the marks of rational development. The weakness of animal intelligence is always in the lack of ability to break away from routine associations; to proceed from two facts to a third. A dog will defend himself if you tease him, but he will not bite. He knows how to use his teeth well enough with his fellows, but towards man he has acquired an attitude of deference.

Animal instincts result from the environment, and must be judged in the environment. When looked at from a human standpoint, these actions seem foolish and irrelevant. We, too, have our rigid instincts, our reflex actions. The closure of the eyelids when an object threatens the eye is a useful protective mechanism; but when we are to undergo an operation, it may be harmful. None the less all the strength of the will is incompetent to keep the eye open. It acts according to its acquired habits. It is true that we are conscious of our error, which animals are probably not; but this is not an essential point. It is proposed to show that the typical kinds of error arise, as do these misapplications of instincts, from the unwarranted application of a general rule to a particular case.

The majority of sense-deceptions support this view. Irritation of any part of the retina arouses a sensation localized in space where an object causing such an irritation would ordinarily be found. In some cases we are freed from illusion by the remembrance of former experiences. Savages are apt to mistake an image in a mirror for a real object behind it: repeated experience allows us to see the image as an image in the plane of the mirror.

Here it is easy to distinguish between the sensory and the memory factors, but in some cases this may be difficult. If you draw a line on a sheet of paper, and cover it up with a second sheet so as just to conceal the end of the line, and show it to some one ignorant of the arrangement, he will be greatly surprised not to find the entire line longer than it is when you remove the second sheet. He does this because it is an uncommon experience to have so little of a line covered up. He cannot help forming a prejudgment on the basis of what is most probable. Is this an error of sensation, or of memory?

There are a host of similar deceptions. One need only refer to the tricks of the conjurer. He takes care to appeal to something true as a rule, but false in this particular case. Again: he directs his gaze towards his right hand, infallibly carrying the eyes of the observers to the same spot, while he is performing the trick with the unobserved left hand. Ordinarily we direct our attention to the point of the field of vision in which an action is going on, and we erroneously follow this rule when we should not. We as mechanically obey the general rule as we close our eyelids when an object threatens us.

The illusion consists in the observation of the general to the exclusion of the special. A high intelligence consists in the command of a wealth of associations, and thus a power of distinguishing between the two. A typical instance is that of the host of persons who religiously record the numbers drawn at the lottery, reasoning,

that, inasmuch as all numbers have an equal chance of being drawn, numbers not drawn now must have a greater chance of being drawn later on. In all games of chance one hears the same argument. The luck must change: good fortune must be followed by bad, and *vice versa*. This common error, again, consists in overlooking the particular case; for while, in many cases, such reasoning would be entirely correct, in the case of the lottery and of games of chance it does not hold, because the numbers are all replaced, the cards newly dealt after each issue, thus making the chances of every lucky event just the same as before. It is a confusion of the case in which the ball is returned to the urn with the more frequent cases in which it cannot be returned. Of the same character is the belief in the luckiness or unluckiness of certain players; in the argument, that, because a person has happened to receive more than a normal share of lucky turns, he has a right to expect the continuance of such luck; or, again, the fancied relations between the weather and terrestrial events, etc.: in short, in many kinds of superstition.

More refined examples of the same kind of error can be found in the fields of art and science. When an architect supports a balcony upon two slender iron pillars, it does not appear pretty, because of the disproportion between the supports and the object supported. The origin of this judgment is to be traced to the fact that we have comparatively little experience with the strength of iron, and much experience with the weight of stone. In general, the impression of solidity carries with it the sentiment of beauty; while the use of iron, however convincing the calculations of the architect, does not carry with it this impression. In various forms of art we see the same association between the form and the material used. Our traditions and the experiences of the race thus play a rôle in our sentiments, and are a factor in the genesis of error. The Greeks built temples of marble in a style derived from times when wood was the building-material. Returning to science, we may examine the famous argument of Zeno for illustration of our main thesis. Achilles cannot overtake the tortoise if the latter is at all ahead of him, because, while Achilles makes up the distance, the turtle has advanced beyond it; and so on. We get the impression of infinite space by the infinite aggregation of finite spaces, because ordinarily such a sum would be infinite; but here the spaces tend to the infinitely small, and so their sum to a finite quantity. In spite of the ages of discussion spent over this problem, it still remains a real source of error; and from this puzzle of Zeno, down to the blind action of a humble animal, one can trace the genesis of error as a faulty application of a general law to a special case; as the instinctive action of an ingrained nervous adjustment to an environment different from the normal.

ABNORMAL SENSE-ASSOCIATIONS. — Increased attention has recently been given to a class of sensory associations of rare occurrence but extremely interesting. When a certain part of the body is hurt, some persons simultaneously feel a pain in a distant and disconnected part of the body: to these the name of "synalgia" has been applied. They are idiosyncrasies, and are of various kinds. So, too, there are "synæsthesias," or cases of an irritation in one place causing a sensation in another. Dr. Fromentel brings these into line with the common experience of sneezing in response to a glaring light stimulation. He does not regard this as reflex, but thinks it psychic in character, and due to the irradiation of a disturbance in the cortex of the brain. The explanation ascribing the connection to an anastomosis between various nerves is also rejected. The peculiar case of hearing colored sounds would also be susceptible to the same explanation. They would be more or less present in all persons, but would only be striking in peculiarly nervous individuals.

BOOK-REVIEWS.

Physical Realism. By THOMAS CASE. New York, Longmans, Green, & Co. 8°.

THIS work contains a criticism of philosophical idealism, or subjectivism, together with the presentation of a new theory which the author offers in its stead. According to the view of Berkeley and his followers, the external world of material things has no real existence, what we call a body being in fact nothing but a cluster of